

Evidence for predation on terrestrial Cane Toads *Bufo marinus* by the Sooty Grunter *Hephaestus fuliginosus* in northern Australia

Aaron M. Davis and Colton Perna

Australian Centre for Tropical Freshwater Research, James Cook University, Townsville, Qld 4811, Australia. Email: aaron.davis@jcu.edu.au

History

The Cane Toad *Bufo marinus*, a native of Central and tropical South America, was introduced to northern Queensland in 1935 as a biocontrol agent and is currently colonizing much of the Australian continent. With toxin-based anti-predator defences evident throughout all life history stages, the impacts of Cane Toad invasion on indigenous fauna, particularly naïve frog-eating predators, have attracted considerable scientific interest. Cane Toads have been implicated in declines of a range of vertebrate fauna throughout northern Australia, both anecdotally (Burnett 1997; White 2003) and quantitatively (Doody *et al.* 2006; Letnic *et al.* 2008). Much field survey effort regarding Cane Toads has focused on the potential impacts of toads on terrestrial and semi-aquatic vertebrates (reptiles and mammals), with evidence of effects, negative or otherwise, on native fish very rare in the Australian scientific literature. There are, however, recent accounts attributing fish kills in aquatic ecosystems in the Northern Territory to Cane Toads (Wilson 2004; Anon. 2006; Grace & Sawyer 2008). The Sooty Grunter *Hephaestus fuliginosus* is a widespread northern Australian freshwater fish with considerable ecological, recreational and spiritual importance (Pusey *et al.* 2004). Noted as an amphibian predator (Allen *et al.* 2002), the Sooty Grunter would accordingly be expected to be a significant Australian fish species potentially susceptible to toad toxicity. The following account documents predation on the terrestrial life history stages of Cane Toads by Sooty Grunters in northern Australia freshwater ecosystems, apparently with minimal evident adverse effect on the fish in question.

Observations

During the course of fish surveys conducted across northern Australia in 2007, anecdotal accounts emerged from discussions with landholders in the Calvert River catchment, Northern Territory, of predation on adult Cane Toads by Sooty Grunter in local rivers. Cane Toads were first documented in the Calvert River region in 1986, following a westerly expansion from Queensland (Alford *et al.* 1995). On several occasions, cursory examination by landholders of stomach contents of Sooty Grunter captured through recreational angling on the Calvert River at Pungalina Station

revealed anuran remains reportedly readily recognizable as adult Cane Toads. Subsequent stomach content analysis by one of us (AMD) of Sooty Grunter specimens collected from western Gulf of Carpentaria rivers during July 2007 strongly supported these observations, with the digested remains of adult toads found in the stomachs of two large fish. The remains of a juvenile Cane Toad (snout-vent length approx. 40 mm) comprising skeleton, tissue and skin fragments were found in a 285 mm standard length Sooty Grunter collected from the Calvert River near Calvert Hills station (17°18.077'S, 137°29.494'E). The partial anterior remains including forelimbs and pectoral girdle of a larger juvenile-small adult toad (snout-vent length approx. 70 mm) were also found in a 265 mm standard length Sooty Grunter specimen captured in the nearby MacArthur River (16°8.322'S, 136°17.590'E).

Discussion

The remains of toads in fish stomachs and anecdotal accounts by fishermen of toad predation suggest consumption of Cane Toads by large Sooty Grunter may not be an uncommon occurrence in rivers of the Gulf of Carpentaria. In both cases in which toad remains were discovered in fish stomachs, the toads were well digested, suggesting ingestion had occurred at least several hours previous to collection, with fish displaying no obvious signs of poisoning prior to capture. Similarly, the anecdotal counts of toad remains in fish stomachs were derived from fish captured by bait and lure fishing, with the continuity of feeding behaviour by fish likewise suggestive of minimal toxic effect associated with toad consumption. These findings add the Sooty Grunter to the relatively limited number of known predators of Cane Toads in Australia (Covacevich & Archer 1975; Alford *et al.* 1995).

The dietary ecology of Sooty Grunter is characterized by marked ontogenetic transitions in diet, with shifts toward an array of terrestrially derived prey types (invertebrates, terrestrial vegetation and terrestrial vertebrates) in larger size classes. In addition to Cane Toads, a diversity of nominally terrestrial vertebrates such as small snakes, lizards, mammal and bird remains have also been recorded from Sooty Grunter stomach content analysis (A. Davis, unpubl.), indicating opportunistic predation on virtually any small terrestrial vertebrate encountered in the aquatic environment. With the high abundance of Cane Toads in many aquatic-riverine environments in the wet-dry tropics of northern Australia (White 2003), and their need for more frequent in-stream rehydration there compared to in wetter bioclimatic regimes (Letnic *et al.* 2008), encounters between Cane Toads and opportunistic fish predators such as Sooty Grunter are probably relatively frequent. While Cane Toad – Sooty Grunter encounters may be frequent, the level of predation of toads by these fish remains unknown.

Predation on the terrestrial life history stages of Cane Toads is particularly interesting in light of the aversion and learned avoidance of consumption of Cane Toad tadpoles documented for a number of Australian freshwater fish, including Sooty Grunter,

during previous feeding experiments (Alford *et al.* 1995; Crossland 2001). Anecdotal accounts also exist of Sooty Grunter deaths from exposure to Cane Toad toxins in Northern Territory aquatic ecosystems (Wilson 2004). Issues relating to factors such as the actual toxicity of adult toads to various fish species, the role of hunger in shaping predatory behaviours of the Sooty Grunter, and possible longer-term selective pressures imposed on aquatic predators following toad invasion remain unstudied.

The occurrence of predation on adult toads by other Australian freshwater fish species with relevant physical capabilities and dietary habits remains essentially unknown. Past research has focused predominantly on the toxicity or palatability to fish of Cane Toad eggs and tadpoles rather than terrestrial life history stages. There are accounts of at least one other northern Australian fish, the Jungle Perch *Kribia rugestris*, feeding on adult toads (both direct observation and toad remains identified from stomach content analysis) with negligible effect evident (Covacevich & Archer 1975). Cane Toad colonization has recently expanded into the distributional range of the Sooty Grunter's closely related congener *Hephaestus jenkinsi*, an ecologically comparable species that similarly preys upon frogs and other vertebrates (A. Davis, unpubl.). A range of additional northern Australian fish species, such as Saratoga *Schleropages jardinii*, Barramundi *Lates calcarifer* and ariid catfishes, opportunistically consume terrestrial vertebrates so presumably these species would encounter adult toads as potential prey. The outcomes of such predator-prey interactions are yet to be documented. How predatory fish guilds respond to toad invasion constitutes one of the many gaps in understanding the community level effects of toad colonization in Australia. In contrast, the drastic population declines observed in some other vertebrate predators has been well reported (Doody *et al.* 2006; Letnic *et al.* 2008).

Acknowledgements

Field work was supported by the Natural Heritage Trust National Competitive Component. Traditional owners and local landholders, particularly Owen Davies of Pungalina Station, are thanked for allowing access to survey sites and providing valuable discussion relating to this topic. Ross Alford is particularly thanked for confirming the identity of the Cane Toad remains. An anonymous reviewer is thanked for helpful comments on an earlier draft.

References

- Alford R.A., Cohen M.P., Crossland M.R., Hearnden M.N. and Schwarzkopf L. (1995) Population Biology of *Bufo marinus* in Northern Australia. In *Wetland Research of the Wet-Dry Tropics of Australia. Supervising Scientist Report No. 101.* (ed C.M. Finlayson), pp. 173-181. Office of the Supervising Scientist, Canberra.
- Allen G.R., Midgely S.H. and Allen M. (2002) *Field Guide to the Freshwater Fishes of Australia.* Western Australian Museum, Perth.
- Anonymous (2006) ABC Radio National Saturday Extra 14th January 2006. The Cane Toad March. <http://www.abc.net.au/rn/saturdayextra/stories/2006/1530836.htm>.

- Burnett S. (1997) Colonizing Cane Toads cause population declines in native predators: reliable anecdotal information and management implications. *Pacific Conservation Biology* 3, 65-72.
- Covacevich J. and Archer M. (1975) The distribution of the Cane Toad, *Bufo marinus*, in Australia and its effects on indigenous vertebrates. *Memoirs of the Queensland Museum* 17(2), 305-310.
- Crossland M.R. (2001) Ability of predatory native Australian fishes to learn to avoid toxic larvae of the introduced toad *Bufo marinus*. *Journal of Fish Biology* 59, 319-329.
- Doody J.S., Green B., Simms R., Rhind D., West P. and Steer D. (2006) Indirect impacts of invasive cane toads *Bufo marinus* on nest predation in pig-nosed turtles *Carettochelys insculpta*. *Wildlife Research* 33, 349-354.
- Grace B. and Sawyer G. (2008) Dead fish and frogs associated with Cane Toads near Darwin. *Northern Territory Naturalist* 20, 22-25.
- Letnic M., Webb J.K. and Shine R. (2008) Invasive cane toads *Bufo marinus* cause mass mortality of freshwater crocodiles *Crocodylus johnstoni* in tropical Australia. *Biological Conservation* 141, 1773-1782.
- Pusey B.J., Kennard M. and Arthington A. (2004) *Freshwater Fishes of North-Eastern Australia*, CSIRO Publishing, Collingwood Victoria.
- White A.W. (2003) Herpetofauna of Boodjamulla National Park and Riversleigh World Heritage Area, northwestern Queensland. *Herpetofauna* 33, 65-77.
- Wilson D. (2004) Do cane toads (*Bufo marinus*) kill fish? *Australia New Guinea Fishes Association News* 19, 6-7.



Though poisonous to many that attempt to consume them, the Cane Toad *Bufo marinus* is food for some native species including the Sooty Grunter. (Tissa Ratnayake)
